SPECIFICATIONS AS A BARRIER TO THE TRANSFER AND UTILIZATION OF NEW TECHNOLOGY INTO NAVY CONSTRUCTION: A CRITICAL REVIEW

Richard Douglas Parrish

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Monterey, California

THESIS

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THE TRANSFER AND UTILIZATION OF
NEW TECHNOLOGY INTO NAVY CONSTRUCTION:
A CRITICAL REVIEW

by

Richard Douglas Parrish

Douglas George Knappe

March 1975

Thesis Advisors: J. A. Jolly
J. W. Creighton

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The possibility that the system of specifications presently followed by Naval Facilities Engineering Command (NAVFAC) acts as a significant barrier to the transfer and utilization of new technology into Navy construction is analyzed. Specific areas are investigated using personal interviews and emphasis is placed on identifying and understanding the barriers and to improve the efficiency of technology transfer within the Navy.

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Specifications as a Barrier to the Transfer and Utilization of New Technology into Navy Construction: A Critical Review

by

Richard Douglas Parrish
Lieutenant Commander, United States Navy
B.A., Hobart College, 1965

and

Douglas George Knappe
Lieutenant, United States Navy
B.A., Marietta College, 1966

Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

The possibility that the system of specifications presently followed by Naval Facilities Engineering Command (NAVFAC) acts as a significant barrier to the transfer and utilization of new technology into Navy construction is analyzed. Specific areas are investigated using personal interviews and emphasis is placed on identifying and understanding the barriers and to improve the efficiency of technology transfer within the Navy.

EXECUTIVE SUMMARY

The objective of this thesis is to demonstrate that the system of specifications presently followed by the Naval Facilities Engineering Command (NAVFAC) is a significant barrier to the transfer and utilization of new technology into Navy construction.

NAVFAC's attempt to standardize Navy construction through the use of type or guide specifications is discussed and several shortcomings are identified.

The current index of NAVFAC specifications was reviewed and random samples taken. It became apparent from the wide range of publication dates that the necessary review and revision process is not keeping pace with the advancement in technology.

Extensive interviews were conducted with civilian architect-engineer and contracting firms. With few exceptions all agreed that the content of the current specifications were cumbersome, ambiguous, and lengthy. It was found that often because of the above mentioned problems, contractors failed to study the specifications sufficiently and bid on contracts after only a cursory review, creating cost overruns, completion delays and resulting claims against the Navy.

The impracticality of the use of universal specifications is discussed. The fact that soil conditions, climate,

and natural disaster threats may require completely dissimilar types of construction makes this basic concept infeasible. Often certain types of material specified in these universal specifications in unavailable. This fact alone caused some of the contractors interviewed to add a significant amount to cost estimates submitted for Navy contracts.

The procedures of utilization of specifications by in-house engineers is carefully reviewed. Considerable divergence was found among the different Engineering Field Divisions on the proper interpretation of type and guide specifications. The procedure for changing an existing specification was investigated. It was found that very few of the engineers interviewed knew of a procedure to request a change to a specification. Very little written guidance on this procedure could be found.

Value Engineering utilized within the Navy today is discussed with several major areas for improvement being recommended.

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I. INTRODUCTION

Why does it cost the Navy 10% to 15% more than a private concern to have an equivalent building constructed? Why does the Navy continue to use expensive metal piping when private industry uses a relatively inexpensive plastic pipe which is in many cases superior? Why won't the Navy use a new type of aircraft runway joint sealer which has a demonstrated life of over nine years instead of continuing to use one which repeatedly fails in around two? (Appendix A) Numerous other examples of the Navy's failure to utilize the latest, most effective, most economical procedures or materials can also be cited.

A. BACKGROUND

Although the above questions reflect a very real problem, they are not intended to imply that the government or the Navy is unconcerned with the transfer and use of the latest technology. On the contrary, both presently have ambitious programs which have as their goal to improve the dissimination and utilization of the latest technological developments. The federal government's oldest and probably most effective technology transfer program is the U.S. Department of Agriculture's Extension Service which was created before the turn of the century. Research results from the Department of Agriculture are effectively disseminated to all states and practically all counties of the

nation through this extension service. Outside the field of agriculture the NASA Technology Transfer Program is probably the best known Federal technology transfer program today. NASA has even contracted the Denver Research Institure (DRI), University of Denver, to carry on a continuing project for the Analysis of Technology Transfer (PATT). PATT is aimed at increasing what is known about the ways that technologies generated for government programs are acquired and applied by persons in non-aerospace sectors of the American economy. In fact, all major Federal agencies have ongoing programs to encourage the transfer of new technology resulting from their R&D efforts to be used by their own organizations and by other sectors.

Of the military services, the Navy has indeed been the forerunner in the field of technology transfer. It was the first military service to issue an implementing instruction requiring an active technology transfer program. The instruction called for the designation of a person as a contact for technology transfer in the various laboratories and components of the Navy Material Command. The Naval Facilities Engineering Command (NAVFAC) in particular has made considerable effort to establish programs to encourage the transfer and utilization of new technological information within its organization. Examples of NAVFAC's efforts in this area include the RDT&E Liaison Program and various Naval Civil Engineering Laboratory (NCEL) activities and publications such as RDT&E Assistance, RAP Briefs, TECH DATA Sheets, and CEL Abstracts.

There has also been a continuing effort by the civilian sector on the subject of technology transfer. Typical examples are the Seminars held by the leading universities such as the one held in late March 1968 on the campus of UCLA. Over two-hundred top level managers from industry and academic scholars met and discussed problems facing industry and institutions of higher learning. Another example of the successful study and implementation of technology transfer is the success story of IBM. IBM has an enviable record in new product introduction yet it has rarely been first with new developments in the field. How? One technical manager estimates that IBM is one year behind at the research stage. However, it is generally agreed that IBM in the marketplace is one year ahead of its competitors. In order to turn this one year disadvantage into one year advantage it is obvious that IBM has been able to transfer whatever technology was required, from the laboratories to the marketplace at a very rapid rate.

There appears to be a conflict between the opening questions of this thesis and the discussion of current endeavors in the technology transfer field. A close analysis of the discussion however, especially the government and military sections reveal the fact that the primary emphasis is on dissemination vice utilization of the technical information. There also appears to be relatively little concern for the

transfer of new[1] technologies <u>into</u> government or military activities from private industry. To discover what inhibits this inflow and utilization of new technologies from private industry to Navy construction activities would help answer the opening questions.

Research and study applied to the introduction of new technology over the past decade has identified numerous barriers that hinder adoption. Major barriers such as communications methods, organizational structures, personalities, and management practices have all been studied extensively. Bibliographies on technology transfer contain numerous books and articles on each of the above topics. Rather than to theorize on the broader scope of barriers to technology transfer the purpose of this thesis is to identify and discuss one particular barrier. The specification system used by the Naval Facilities Engineering Command is that barrier.

B. OBJECTIVE

The objective of this thesis is to demonstrate that the system of specifications presently followed by NAVFAC is a significant barrier to the transfer and utilization of new technology into Navy construction. By breaking down this barrier major strides can be made towards providing higher quality Navy construction projects at a lower cost.

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[1] New is defined as: that which is new to the user but not necessarily new in time.

C. METHODOLOGY

The major source of data used as the primary basis for analysis was obtained through extensive personal interviews conducted by the authors. Prior to commencement of the interviews the authors undertook two studies: (1) all pertinent NAVFAC and Engineering Field Division instructions and directives were carefully reviewed for possible specification barriers to the transfer of technology and (2) an extensive study effort was undertaken on the proper procedures for conducting personal interviews.

Approximately 40 personal interviews were then conducted at various NAVFAC Engineering Field Divisions and at civilian firms. The personnel interviewed within the Engineering Field Divisions consisted of engineers, Branch Managers and Division and Department Heads. The civilian interviews were with the heads of the respective firms. Approximately one fourth of the interviews were with civilian architect-engineer firms and contractors.

All interviews were conducted with both authors present and began with an explanation of the nature of the research. The interviews were not formalized but were tailored to the interviewee and were intended to provide the researchers with an insight into the atmosphere, attitude, and functions of the activity being interviewed. The goal was to establish a rapport with the interviewee and then find out his candid opinions on the various aspects of NAVFAC's specification system.

II. THE SPECIFICATION

A. GENERAL

In essense, the Naval Facilities Engineering Command, (NAVFAC), with cognizance over all Navy land structure construction, has attempted to standardize its building projects through the use of type or guide specifications. As will be discussed in detail later in the chapter, these guide specifications cover virtually all aspects of Navy construction projects and are to be used as manuscripts in preparing individual project specifications. Guide specifications will normally refer to various government publications such as Federal and military specifications, the National Bureau of Standards Handbook, and other similar documents. They also may refer to non-government documents such as American Society for Testing and Materials (ASTM), United States of America Standards Institute Standards, American Welding Society and others of this nature. The NAVFAC Engineering Field Division (EFD) specification writers or civilian architect-engineer firms then tailor these guide specifications so that they will be appropriate for a particular project. On the surface this seems to be a legitimate undertaking, however in reality there are numerous inherent shortcomings. The remainder of this chapter will be devoted to the identification and discussion of the aspects of this specification system which act as a barrier to the transfer and use of new technology.

B. OBSOLETE SPECIFICATIONS

There are certain characteristics of the guide specifications used by NAVFAC activities which hinder the expeditious and economical completion of a Navy construction project. The one which probably has the largest impact is the fact that many of the guide specifications themselves and the referenced specifications within them are obsolete. Appendix B gives the statistical breakdown of the age distribution of the guide specifications currently in use by NAVFAC. It is based on a random sample of 107 specifications taken from NAVFAC Publication P-34.[2] Noting that the mean age of the random sample is 1966, with some being as old as 1954, it is apparent that the review and revision process is not keeping up with advancements in technology. The present system calls for a review of NAVFAC used Federal, Military, and Special Specifications whenever the existing edition is five years old. NAVFAC Headquarters personnel are tasked with this review and admittedly they are not sufficiently staffed to keep these reviews current. In fact, because of the rapid advancements being made in technology today, a daily review would hardly be adequate to keep abreast of new developments in certain areas.

Although there is a provision in each guide specification for the user to update the referenced specifications to reflect its latest revision, this does not account for

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[2] P-34 is the index of NAVFAC Specifications used in contracts for Public Works.

the very real possibilities that either the revision is outdated or that a completely new product exists to do the job. Numerous examples of obsolescence were discovered by the authors. One concerning a design for gasoline storage is illustrative. A public works officer contracted a local architect-engineer to produce a design for storage of unleaded gasoline for the Navy Exchange Service Station. In accordance with standard procedure, the architect was provided with Navy specifications to use in his design. These specifications however, called for the use of a metalic tank which had long since been supplanted by a fiberglass tank in the commercial community. The fiberglass tank was less expensive and more durable than the type called for in the Navy specification. Fortunately the architect; one, was aware of the new product; two, made the effort to introduce it; and three, was able to get the cognizant Navy personnel to commit themselves to its use. However, if any of the above three elements were missing, the Navy would have spent more money for an inferior product due to the use of an obsolete specification. In the opinion of the authors, one of these three elements: awareness, effort, commitment, is missing a significant amount of the time.

C. CONTENT OF SPECIFICATIONS

Another feature of the NAVFAC guide specifications which has detrimental effects on Navy construction projects is their structure and content. Every civilian architect-engineer

and contractor, and most of the Navy employed engineers who were interviewed agreed that NAVFAC specifications were very lengthy, cumbersome, and ambiguous. To impress upon the authors that Navy specifications were excessively long, one of the architect-engineers interviewed made a bet that he could sit at his desk and point out the Navy specifications on the bookshelf across the room just by the thickness. He did it! Apparently this wordiness has evolved over the years by using the philosophy that if you add enough verbage to the specifications you can cover all contingencies and thereby close the loop-holes and reduce contractor disputes. Unfortunately, the ultimate effect of this process is merely to compound the initial problem.

The specifications are so long and cumbersome, 30 pages for a ten foot section of pipe was an example shown these authors, that often the contractors do not study them sufficiently. By their own admission, contractors will often get the basic idea of the job from the plans, check only the major procurement items in the specifications and then bid the job based on common construction practices rather than the detailed specifications. One reason for this is that approximately 90% of the work is subcontracted, often to small local companies who do not have the personnel or resources to research the unique Navy specification system. This research procedure, even when attempted is also hampered considerably by the fact that many of the specifications are not available locally at the Public Works Offices and Centers.

This claim was verified by these authors. Using a random sample of 100 NAVFAC guide specifications taken from P-34, one Public Works Office held only nine.

For the contractor or subcontractors to wade through these lengthy specifications and research all the referenced military and Federal specifications and standards is a prohibitive task. Consequently, they often only give them a cursory review and the result is that they cannot use many of the methods and materials upon which they originally based their bid. They are forced to go to other suppliers at a higher cost and often at the expense of a significant time delay. At the very least, the number of disputes with Navy inspectors increases considerably, usually resulting in claims against the Navy, completion delays, and cost overruns.

D. APPLICABILITY OF SPECIFICATIONS

Another problem concerns the applicability of specifications. This particular drawback was concurred with by the Navy employed engineers and outside firms alike. It concerns a fallacy in the basic concept of standardizing specifications for Navy-wide construction. To specify a particular material for a particular job for virtually any location in the world is not feasible. The main reason is that different soil conditions, climate, natural disaster threats, etc. may require completely dissimilar types of construction. Unavailability of certain types of materials in some areas is another reason that makes a universal

specification impractical. One architect-engineer stated that he added 20% to his cost estimates on Navy contracts because of the difficulty in obtaining materials which meet the specifications. Sometimes a material is no longer in production which means that an extensive search for remaining stock must be made or the product must be specially fabricated for that particular job. Consequently, adhering strictly to one specification for all areas of the world, in all cases, would result in major construction deficiencies and escalated material costs.

III. THE PROCEDURES FOR USING SPECIFICATIONS

A. IN-HOUSE DESIGN ENGINEERS USE OF SPECIFICATIONS

The following quote from the report of a conference sponsored by the Denver Research Institute, University of Denver seems appropriate to introduce a discussion of the role of design engineers and their use of specifications. "There seemed to be an underlying assumption at this conference that action for really effective technology transfer should start with potential users, rather than the sources. The potential user must be identified, aroused, motivated, aware that a technological solution exists, and willing to exert effort to adapt the potentially useful technology to his needs," [Ref. 16, p. 3]. In this study, the potential user is the Navy, and one could trace the benefits through the government and back to the taxpayer. However, this study is concerned with the Navy design engineers and how the specification system effects their role as potential users of new technology.

Only 25% to 30% of Navy construction design efforts are initiated by in-house design engineers. The remainder is contracted out to civilian architect-engineer firms. The engineers at the NAVFAC Engineering Field Divisions (EFDs) however, review all major architect-engineer design at the 30%, 60%, and 100% completion levels. In effect, they have an input into all Navy construction design. Are these

in-house engineers providing the Navy with the best design available using the newest technology or are they being hampered by a rigid adherence to the specification system?

Consider the procedure used by the in-house engineers when working on a project design. The normal method for the engineer is to take the applicable NAVFAC guide specification and tailor it to the specific job. The guidance establishing this procedure is found either on the cover sheet or in the notes of NAVFAC type specifications. A typical statement would be: "This 'Type' specification shall not be referenced but is to be used as a manuscript in preparing project specifications. Appropriate changes and additions as may be necessary and as required by the notes must be made," [Ref. 13, p. 3]. If the specification is a tri-service specification, the note also includes the sentence: "No deviations shall be made from this specification without prior approval of the Naval Facilities Engineering Command," [Ref. 12, cover page]. These authors found considerable divergence among the various EFDs visited concerning the interpretation of the above quoted guidance. What constitutes an appropriate change, addition, or a deviation receives a liberal interpretation by some personnel and a very conservative one by others. Therefore, some personnel make changes freely while others feel tightly bound by the printed word in the specifications.

Generally speaking however, the policy of using a guide specification as a manuscript, even with a liberal

interpretation, does not lend itself to the application of the newest technologies to Navy design efforts, especially if the guide specifications are obsolete. Without ample incentive to do otherwise, it would be fairly easy to simply utilize the guide specifications, making the obvious changes but not really researching the possibilities of using new materials or methods. To illustrate the potential detrimental effects, consider NAVFAC's specification in reference to lintels over windows. The effective NAVFAC specification called for 4-inch lintels over windows while the industry standard for the same construction was changed to three inches several years ago. The 3-inch lintels have proven more than satisfactory yet because the NAVFAC guide specification requires 4-inch lintels, the Navy continues to pay the extra cost of using larger lintels in most of its construction.

According to the interviews a major factor contributing to this tendency to rely on the guide specifications rather than researching each project is the fact that the design engineers are always working under a time constraint. The engineers are given a deadline to complete a project specification and to take the time to completely research each aspect of the job would make it most difficult to meet that deadline. Whatever the reason, the end result is that the guide specifications are often being used with little critical review which has the effect of perpetuating a given method with given materials even though improved ones may exist.

B. CHANGING A SPECIFICATION

The research problem notwithstanding, it seemed logical to the authors that there must be numerous circumstances where an engineer's previous experience and professional knowledge provided him with a better method than the one referred to in the guide specifications. Given this circumstance, what would the engineers do to initiate a change to incorporate improvements? The response to this question during the interviews was very surprising. In fact, very few personnel interviewed could identify a definite procedure for recommending a change to a specification. Some said they would tell their branch head, some would submit a beneficial suggestion, and others were not concerned with the problem, but almost no one could identify the proper procedures for submitting a change. Further investigation revealed that the only written guidance concerning changes to NAVFAC specifications is in the form of a sentence somewhere in each specification which gives an address where recommended changes are to be sent. It would seem that a more active program to "arouse and motivate" the engineers who work with the specifications daily would go far towards updating the specification system and thereby improving Navy construction.

Under the present system, to actually have a change recommendation accepted and incorporated into a specification is an unacceptably long process. By the time everyone up through NAVFAC, or even beyond if another organization

has cognizance over the specification in question, has accepted it, it is certainly too late to effect the particular job that instigated the request. The change itself may even be outdated. Appendix A is an actual case which has been included to illustrate how the lack of timely action on change requests can result in costly delays in introducing superior products into Navy construction.

C. SPECIFICATION WAIVER AUTHORITY

There appears to be no official position by NAVFAC headquarters on the granting of waivers to specification requirements. The procedure does however seem to be used on a very informal basis, and to different degrees depending on the personnel involved. The process seems to work as follows: Anyone, from the Navy inspector at the site to the personnel at an EFD, may request a waiver of specifications. Depending primarily on the magnitude of the deviation, the specification in question, the urgency of the situation, and most importantly the personnel involved, a decision may be made on the waiver at almost any level. That is, sometimes the Resident Officer in Charge of Construction (ROICC) grants the waiver and sometimes it gets all the way back to NAVFAC Headquarters. There is one universal characteristic of the whole informal waiver process however, and that is the hesitancy of all concerned, especially NAVFAC Headquarters, to grant any waivers in writing. This reluctance down through the chain of command to make a commitment in

writing naturally breeds caution by all personnel, even when a deviation from the specifications is obviously the best solution.

IV. INFLUENCE OF SPECIFICATION SYSTEM ON NON-GOVERNMENT PERSONNEL

A. ARCHITECT-ENGINEERS DOING NAVY DESIGNS

Outside architect-engineer firms do approximately 70% to 75% of all Navy construction design work. They do virtually all of the major design jobs. Consequently, the impact of the specification system on these Navy contracted architect-engineer firms is an important aspect of Navy construction.

To a man, every one of the numerous architect-engineers interviewed agreed that the Navy's specification system had detrimental effects on the final product. They felt that it inhibited them from using the most recent design features and materials. It also cost them a significant amount of time wading through the lengthy specifications and looking up the references in the guide specifications. Their candid opinion was that reputable architect-engineers could provide the Navy with a better design, for less cost, and much faster, if they were not as restricted by specifications as they presently are.

Although there are cases where an architect-engineer makes the effort and succeeds in implementing his idea even though it differs from the specification, the normal practice seems to be that it is easier to do it the Navy way the first time. The fiberglass storage tank mentioned earlier is an example of successfully breaking down the specification barrier. Several examples of "give them what they

want" or "the Navy way" approach were also found. There was one case in particular concerning a boiler specification which appears to be representative and is the type of situation which discourages an architect-engineering firm from introducing new ideas. In this case the architect-engineer went to the local officer in charge of construction and received verbal permission to use a boiler design which differed from the Navy specifications. The architect-engineer's design was more modern and certainly included boiler systems which were more available and therefore less expensive. However, when his design reached the cognizant EFD for review, it was rejected and he had to redo the entire boiler section. Needless to say this particular architect-engineer will be very hesitant in the future to introduce new technology which deviates from the Navy specifications.

B. THE ARCHITECT-ENGINEER WHO AVOIDS NAVY CONTRACTS

Another aspect of Navy construction which seems prevalent and which tends to contribute to the Navy's getting less than optimal work on their construction projects has to do with the architect-engineers and contractors who avoid government work. Although there are other reasons for this, the specification system seems to be the predominant one. Almost all of the architect-engineers and contractors interviewed said that they lost money on their first few Navy contracts because they simply were not prepared to handle the specification system. Besides learning to handle the

specifications better after the first few contracts, they also learned to submit higher bids to cover the added expense.

All of them did state that if they were offered roughly equivalent commercial and Navy contracts they would take the commercial one every time. Consequently, the better firms and contractors who are competitive in the commercial market are for the most part not doing the Navy construction. One architect-engineer interviewed said that as a matter of professional pride he researches the reasons whenever contractors do not bid his designs. He has found over the years that the main reason why contractors do not bid his Navy designs is that they do not want to contend with the specification system and associated problems. When the best in the field is only dealing with the Navy when commercial work is not available, the Navy is not getting the optimum product much of the time.

V. VALUE ENGINEERING

Value Engineering has the potential to be one of the most useful tools available to the EFD's in the reduction of existing specification barriers. While value engineering does not deal solely with specifications it can be used to improve specifications. For that reason a discussion of value engineering and its potential is presented in this thesis.

A. BACKGROUND

The Navy's value engineering program is currently governed by NAVFAC instruction 4858.1B entitled Naval Facilities Engineering Command Value Engineering (VE) Program dated 5 April 1973. Value Engineering is described by the Secretary of the Navy as "... an effective method of obtaining efficient functioning of parts, components and end items at the most economical cost of total ownership. VE frequently provides other benefits of military worth, such as improved performance, increased reliability and maintainability," [Ref. 17].

While the SECNAV does not refer specifically to specification barriers and technology transfer in this description it is obvious that he is describing the transfer of new technological information into the field, thereby obtaining the greatest efficiency from both men and their machines.

B. IN-HOUSE VALUE ENGINEERING

The in-house program operates on the premise that Value Engineering is similar to a number of techniques and skills which all engineering related personnel must master and apply to achieve reduced product cost and increased performance. To this end, a training program has been established and all practicing engineers are receiving training in the principles and applications of value engineering. The Design and Architectual engineers that were interviewed by the authors strongly maintained that it is their obligation to provide the most economical design using the current specifications and they, therefore, are routinely practicing value engineering. Value engineering, the majority contended, is a duplication of effort and amounts to a criticism of the designs produced by the Project Engineer or the architect-engineer. When questioned closer on this point most agreed that value engineering was in fact an excellent idea and more attention should be placed upon it.

C. THE ARCHITECT-ENGINEER/CONTRACTOR VALUE ENGINEERING

Most new technology comes from the architect-engineering and contracting firms under contract with the government. This is quite understandable when one remembers that these private firms must survive in private industry and therefore are always alert for new products or procedures which will make them more competitive.

The Architect-Engineer/Contractor should be a major source of new technical data. However, because of the complexity of requesting a modification of an existing specification, (chapter II), and excessive time lags between input and response, the industry tends to avoid the use of value engineering when dealing with the government.

It is the contention of the authors that because of the pressure of performance, job completion, current rapid technical changes and most importantly the futility of attempting to change existing specifications, optimum design and construction is far from being achieved.

D. DEFICIENCIES IN VALUE ENGINEERING

Several major areas for improvement of the current value engineering at Engineering Field Divisions are presented and will be discussed in their order of importance as seen by the authors.

1. Staffing

Currently the Engineering Field Divisions (EFD's) have one engineer assigned to Value Engineering. This is inadequate and may be a prime reason why value engineering must struggle to survive. At best the Value Engineer can be expected to "put out fires" rather than establish an effective Value Engineering department.

The recommendation of the authors would be to assign at least one, preferably two, additional engineers to the Value Engineering program. One of these engineers should be the RDT&E liaison officer. In this way the division would

have access to the most current information available and thereby reduce the existing specification barrier.

The total additional cost of the manpower to staff the required new position might come from the cost savings resulting from an efficient program.

2. Incentives

Since its creation value engineering has had significant payoffs in DOD contracts. Therefore the authors believe that an additional means to obtain full and enthusiastic support for the program should be investigated.

The Value Engineering Program Clause provides for monetary rewards to contractors for their value engineering efforts. Current procedures for providing recognition and rewards through existing programs such as the Beneficial Suggestion Program and The Annual Performance Award Program have not proven effective or adequate. It is therefore suggested that some form of sharing of the value engineering savings be developed as an additional incentive to all in-house engineers. Whether or not the incentive is provided in a form of shared savings or a flat bonus, monetary considerations may be the missing ingredient which could sport interest in the value engineering program.

It is the contention of the authors that deserving employees should be recognized and awarded for effective cost savings actions in all government contracts. A cash incentive program should therefore be established as soon as possible.

VI. CONCLUSIONS/RECOMMENDATIONS

The purpose of this study has been to examine the hypothesis that the current system of specifications utilized by NAVFAC is a significant barrier to the transfer and utilization of new technology into Navy construction.

A. CONCLUSIONS

1. Specifications are indeed a barrier to the transfer of new technology into the Navy.
2. The specifications are generally obsolete and the present system for updating them is inadequate.
3. In-House design engineers tend to use the current specifications rather than attempt to inject new technology because of the difficulty incurred in changing specifications, and the lack of time for research.
4. Architect-Engineer firms tend to do it the "Navy Way" rather than battle the specification system.
5. The present specification waiver authority is ambiguous and often misused.
6. Value engineering within the Navy is not being utilized to the fullest extent.

B. RECOMMENDATIONS

1. The waiver authority should, wherever possible, be granted to the applicable EFD in writing by NAVFAC.
2. The specific recommendations on Value Engineering presented in this thesis should be instituted as soon as possible.

APPENDIX A

RUNWAY PVC JOINT SEALER

The first case is representative of the transfer of technology from a civilian firm to the Navy via a Value Engineer at one of the NAVFAC Engineering Field Divisions. This opportunity for technology transfer often occurs when industry feels they have a product which is superior to that which is presently being used by the Navy. An industry representative simply attempts to market his product through one of the value engineers at an Engineering Field Division. The particular product in this case is a joint sealer for runways and it demonstrates quite well how the present administrative system for changing a specification acts as a barrier to technology transfer.

The Value Engineer at NAVFACENGCOM Western Division became aware that the Navy was having problem with the runway sealer presently in use. Rapid deterioration was common with the defective material becoming hardened and loose. Besides the direct repair and replacement cost involved, there was concern that the deteriorating sealer was causing damage to the jet aircraft using the runways. Consequently, the value engineer from Western Division, during a visit to NAVFAC Headquarters in October 1971, made a verbal request that the NAVFAC Specifications Branch reevaluate NAVFAC Specification 46 Ye which covered runway joint sealers. He

provided extensive data on a runway joint sealer produced by Superior Products Company (which he was convinced was of a higher quality than that currently being used) and requested that NAVFAC either consider a change to Specification 46 Ye to include the new product or grant a general waiver allowing its use. While the type of sealers required by Federal Specifications SS-S164 and SS-S-167b were repeatedly observed to have shown partial or complete failure within 18 months, the type of PVC sealer offered by Superior Products Company was demonstrated to be in excellent condition after nine years of use at various civilian airports. Additionally, the current specification only requires a manufacturer's warranty of one year whereas the new PVC sealer at that time carried a five year warranty with the prospect of increasing it to ten years.

Approximately two months later the Value Engineer at Western Division received a reply to his request which is included as enclosure (1). Basically the response was very non-committal and introduced a considerable further delay before any positive action would be taken on changing the specification in question. Paragraph two in effect says that the new PVC sealer does not meet the specifications and no action will be taken until further investigation is conducted. The requestor was told to personally inspect the present condition of the new type sealer which had been installed on a runway at NAS, Fallon, Nevada in October 1965, apparently in violation of specification 46 Ye. This

expensive and time consuming step was required even though the Value Engineer had already committed himself to the product's superiority and it had demonstrated excellent performance for over nine years at various international airports. It is the last two sentences in paragraph four that really give an indication of the time consuming process involved in attempting to implement a significant change to a specification. Basically, they say that if his personal inspection at NAS Fallon is satisfactory then the new PVC can be used on specific selected projects and thereby be further evaluated for possible future inclusion in NAVFAC criteria. Since the new sealer has already proven itself for nine years, this could be a very long evaluation period. It is apparent here why some private companies do not consider it worthwhile to attempt to introduce their technology into the government.

Although his personal inspection of the NAS Fallon installation proved satisfactory as expected, no opportunity to use the new PVC sealer on a selected project had occurred by June 1972. At that time the Value Engineer from Western Division, in a letter dated 14 June 1972, submitted an official request to NAVFAC to change Specification 46 Ye. The letter was submitted under the Value Engineering/Cost Savings Program and is included as enclosure (2). The letter request was processed by NAVFAC and was eventually forwarded to the Naval Civil Engineering Laboratory at Port Hueneme, California for evaluation. Enclosure (3) is the Civil

Engineering Laboratory's report which attests to the superior performance of the new PVC sealer. The report is dated 7 December 1973, over two years from the time the initial request was submitted. Even with the favorable endorsement by CEL in December 1973, as of November 1974 the Value Engineer at Western Division had not received and definite decision on his change request.

In summary then, even when a significant amount of evidence exists to support claims of superiority of a product, it can still take over three years to effect a change in the governing specifications to allow the product to be used.

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D. C. 2 390

FAC 0432/EF:bab

DEC 1 7 1971

From: Commander, Naval Facilities Engineering Command
To: Commanding Officer, Western Division Naval Facilities Engineering Command (Code 04B)

Subj: Evaluation of Superior Products Company PVC Joint Sealer

1. In response to your verbal request, an evaluation of the brochure and articles on subject materials has been completed by cognizant personnel of this command.

2. Our evaluation indicates that Superior Products PVC joint sealer does not conform to any of the materials specified in NAVFAC specification 46Ye, and could not be furnished as an acceptable joint sealer on any Navy project without a specific waiver. It is felt that there is insufficient justification at this time for granting a general waiver or modifying the requirements of 46Ye to allow Superior Products to bid its material.

3. However, it is noted that the brochure refers to an application of "Superseal" 444/777 under contract NBy 61195 of October 1965 at NAS Fallon, Nevada. If this installation has proven to be acceptable and superior to materials presently being used, this Command will consider its further use.

4. Accordingly, it is suggested that you inspect the installation in question at NAS Fallon, and report on the condition of the joints and joint material (include photographs if feasible). If your evaluation is favorable, it is suggested that it be specified for selected projects along with the other materials meeting the requirements of 46Ye. If the Superior Products Company sealer is used, both the installation and service should be closely monitored and reported, so that it may be considered for inclusion in NAVFAC criteria.

B, ..LES

Enclosure (1)

DEPARTMENT OF THE NAVY
WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
SAN BRUNO, CALIFORNIA 94066

IN REPLY REFER TO
04B:RE:nd
14 June 1972

PREFACE

The Value Engineering effort of the Western Division, Naval Facilities Engineering Command is constantly searching for new methods, products or materials which will improve construction quality, eliminate high areas of construction costs, and reduce future maintenance costs. A 1969 Air Force report by Mr. Leslie B. Crowley, Senior Consultant, Directorate of Civil Engineering, Headquarters U.S.A.F., stated that the Air Force had annual jet engine maintenance costs of $130,000,000 caused by rocks and foreign objects.

Except for the more costly polyurethane and polysulfide, present airfield joint sealants are not resilient enough to reject non-compressibles, often become sticky in warm weather and retain the non-compressibles even though vacuumed and swept, and most frequently shrink and harden in a short time. Jet engine intake is powerful enough to pull these non-compressibles out of the sticky sealant and the loose hardened sealant out of the joints into the jet engine and cause subsequent damage.

Mr. Crowley's report was discussed during the Value Engineering Seminar held at the Naval Facilities Engineering Command in October of 1971, at which time a verbal request was made to the Specification Branch, Naval Facilities Engineering Command, for evaluation of the Superior Products Comapny PVC Joint Sealers in 46Ye criteria.

Enclosure (1), Naval Facilities Engineering Command letter of 17 December 1971, provided the authority to conduct a limited study and an investigation to substantiate justification for updating the requirements of the 46Ye specifications.

An initial investigation of Naval Air Station, Fallon, Nevada and Naval Air Station, Lemoore, California, clearly pointed out the importance of obtaining photographs and

Enclosure (2)

additional information of other installations within the geographic area of the Western Division having long histories of product success of Superseal 444 and Superseal 777, hereinafter referred to as 444 and 777. Because of the nature of information received, publications studies, and letters of testimony of management and operational personnel, sufficient positive documentation has been compiled for submission of the Superior Products Company 444/777 materials for specification approval under the Engineering Investigation Program.

Observations of bases and airports, photographs, publications studied, and joint sealant life investigated generally showed significant failure of the present Federal Specification SS-S-164 (SS-S-1401A), and SS-S-167b materials within six (6) months to eighteen (18) months. Sealants which, at present, do not qualify under Federal Specification 46Ye have been observed and certifications received from the various air bases and airports where the Superior Products materials have been in place nine (9) years or more are still in excellent condition. This information pointed out the following items of interest:

1. The cause of jet motor damage is:

    a. Aircraft maintenance, to a limited degree, established by observing small nuts and bolts found generally on the apron area.

    b. Station forces maintenance:

        (1) Dust and small rocks blown onto the runways and aprons from untreated soil adjacent to runways, taxiways, and aprons.

        (2) Inadequacies of available sweeping and vacuuming methods of runways, aprons, and taxiways (non-compressibles adhering to sticky and unresilient sealants), (shrunken and hardened joint sealer not being removed).

        (3) The primary and most obvious source of motor damage was hardened pieces of deteriorated joint sealants.

        (4) The joint sealer failure (3), above, contributes to other areas of failure.

            (a) Spalling of joints.

            (b) Random cracking.

            (c) Faulting (raised or lowered slabs).

2. Areas and means of eliminating joint failures:

   a. Utilization of joint sealant materials with a history of acceptable usage.

   b. Application of joint sealant:

      (1) Joint preparation: Joints must be clean and dry. The sealant is very fluid at the pouring temperature, and requirement for use of cord or roving at the bottom of the joint should be enforced to insure against loss of material (voids) and to insure obtaining of proper joint sealant shape factor.

      (2) Cleaning of joints:

         (a) New concrete pavement: All new joints (except expansion joints) should be formed or sawed to produce a minimum joint size of 3/8" x 1¼" at appropriate joint spacing. Prior to sealing the joint, surfaces should be cleaned of all dirt, curing compount residue, laitance and any other foreign material. Clean by sandblasting thoroughly. Immediately prior to sealing, joints should be blown, using a minimum of 100 psi oil-free compressed air.

         (b) Old concrete pavement: For resealing of joints, the old sealant in the joint should be plowed out and the joint widened to ½" x 1¼', using a concrete saw. Joints should be cleaned of all old sealant. Remove all foreign material by sandblasting thoroughly. Immediately prior to sealing, joints should be blown, using a minimum of 100 psi of oil-free compressed air.

      (3) Application: Joints should be filled from the bottom of the 1¼' deep joint to ¼" below flush, $\pm$ 1/16".

      (4) Sealant should not be poured below 50 degrees F.

      (5) Joints to be clean so that no residue will remain on finger rubbed over surface of saw cut after sandblasting.

3. Obvious signs of sealant failures:

   a. Bubbles in the sealant allowing water, jet fuel, sand, etc., to infiltrate through the joint into the subgrade.

b. Loss of sealant bond to joint sidewall.

c. Cracking or cohesive failure in sealant.

d. Flowing of sealant down into or out of joint.

e. Loss of resilient or rubber-like properties.

f. Sealant that has pumped or extruded out of joint.

g. Assimilation of sand into soft sealant which accelerates hardening.

The report was compiled from observations and evaluations of items 1 through 10 by the Western Division Value Engineering (assigned the reporting responsibility).

Items 11 through 23 are solicited reports, comments, tests and allied information related to the performance capabilities of the Superior Products sealants being studies and investigated.

Index

1. NAS Fallon
2. NAS Lemoore
3. McClellan AFB
4. Nellis AFB
5. Hamilton AFB
6. Kingsley AFB
7. Travis AFB
8. Los Angeles International Airport
9. Sacramento Metropolitan Airport
10. California Highway No. 395, El Cajon Pass
11. Wichita Municipal Airport
12. Kansas City International Airport
13. Mather AFB
14. Dallas-Fort Worth International Airport
15. Illinois State Toll Highway Authority
16. Louisiana, Department of Highways, Assistant Materials Engineer
17. Arizona State Highway - Advertisement for Bids:
    Nogales - Tuscon Highway
    Cordes Junction - Flagstaff
18. Florida-Jacksonville Port Authority - Technical Specialist - Warranty
19. San Francisco International Airport - Warranty
20. Hill AFB: (a) Contract, (b) Warranty, (c) Material Report, (d) Laboratory Report
21. Louisiana, Greater Baton Rouge Airport District - Supplier Warranty
22. NAS Alameda, California - Specifications
23. Publications:
    a. Public Works Magazine, Nov 1971 - PVC Joint Sealants
    b. Civil Engineering Magazine, Mar 1972 - Pavement Joint Seals
24. Symposium:
    a. Bureau of Public Roads, Washington, D.C., Sept 1970
    b. Highway Research Board, Washington, D.C., Jan 1972
25. Manufacturers' literature and specifications.

ONE-YEAR WARRANTY MATERIALS (PRESENT 46Ye MATERIALS)

a. Initial cost first-year installation

b. Replacement cost during year 2

c. Replacement costs during years 4-6-8-10

d. Initial cost first-year installation of 444/777 materials (10-year plus life)

TEN-YEAR WARRANTY MATERIALS (SUPERSEAL 444/SUPERSEAL 777)

	Materials		Joint Preparation for Resealing Cost per LF	Material Cost per LF (1# to 4 LF of Joint)	Cost per 100,000 LF	
a.	164		$0.15	$0.15	$ 18,750	
		167b	0.15	0.24		$ 21,000
b.	164		0.15	0.15	18,750	
		167b	0.15	0.24		21,000
c.	164		0.15 (ea 2 yrs)	0.15 (8 years)	75,000	
		167b	0.15	0.24 (8 years)		84,000
					$112,500	$126,000
d.	444		0.15 (1 applica'n = 10 yrs)	0.24	21,000	
		777	0.15 (1 applica'n = 10 yrs)	0.35		23,750

Maximum savings: 10 years in place	444	$ 91,500	
	777		$102,750

NOTE: The above savings computed at an average cost, not reflecting escalation increases, shows an existing hypothetical joint sealant maintenance program indicating a 10-year potential saving.

The joint cleaning operation removes and eliminates the old hardened and oxidized pieces of sealant, which cannot be removed by sweeping or vacuum maintenance, but which are sucked up by jet aircraft engines.

A second magnitude of savings is the extension of service life of runways, aprons, etc., by elimination of spalling, pumping, and damage to subgrade.

Third, and primary magnitude savings is accomplished by the elimination of "foreign object" jet engine damage reported to be $130,000,000 in 1969 by the U.S. Air Force.

A conservative estimate of Naval jet engine damage warrants the basic intent of this report which is an annual savings, by elimination, of an area of high cost maintenance.

CONCLUSIONS:

1. The PVC joint sealer 444/777 gives evidence of being superior to corresponding SS-S-164 and SS-S-167b, the products now specified.

2. The joint sealers now used often require replacement from approximately six months to one year, with total replacement usually necessary within two to three years. 444/777 will require replacement a minimum of once every ten years or more. 444/777 has been observed in excellent condition after nine years in place.

3. Navy aircraft jet engine damage at all land-based facilities may be reduced $50,000,000 per year (estimated). This is an estimated conclusion based on an Air Force report of 1969 and is not substantiated by any known Navy report of yearly jet motor damage by "foreign objects."

RECOMMENDATIONS:

1. That Superior Products PVC joint sealants 444 and 777 be evaluated for Federal Specification approval.

2. PVC sealant 444 is for sealing joints in concrete highways and runways, and PVC sealant 777 is for critical areas of concrete airfields subject to jet-fuel spillage and limited jet-blast such as taxiways, parking areas, wash racks, maintenance aprons, and maintenance hangars.

3. That the attached manufacturer's recommended non-proprietary performance specifications for the PVC 444 and PVC 777 sealants be reviewed for consideration as the basis for respective Federal specifications for all services for a premium type, long-lasting sealant highly resistant to aging and weathering.

4. That the present military one (1) year warranty for joint sealants be increased to 5 years non-prorated plus 5 years prorated. The job quality control then becomes the direct responsibility of the contractor/applicator to insure application during dry weather, temperatures at time of application above 50 degrees f, joints cleaned as specified, and joint filling accomplished as specified. Improper cleaning will produce bond failure initially, as will overfilling. The 444/777 sealants are

self-inspecting to the point where the Government Inspector will inspect for Government acceptance of installation to see that the joints are filled to the proper depth, filled to ¼" ± 1/16" below flush with pavement surface, and to test for bond of the sealant to the joint sidewall. Any and all of these deficiencies would have to be corrected by removing, cleaning, and applying new 444/777 sealant.

RICHARD ENGELS
Special Assistant for Value
Engineering

LABORATORY
PORT HUENEME, CALIFORNIA 93043

IN REPLY REFER TO
L53/DJL/pj
YF53.534.007.01.011
SERIAL 3169

RECEIVED 048 DEC 10 1973

DEC 7 73

From: Commanding Officer
To: Commander, Naval Facilities Engineering Command

Subj: WESTDIVNAVFAC Value Engineer Study of Polyvinylchloride Joint Sealant Performance; review and comments on

1. NAVFAC requested that NCEL review and comment on the subject informal report, submitted by Mr. Richard Engels, WESTDIVNAVFAC, concerning performance of a polyvinylchloride (PVC) joint sealant material, Superseal 777, on a number of military and civil airfield installations. There is presently no Federal Specification for this type sealant material. The report recommended that sealants such as Superseal 777, which can be warranted for up to 10 years, be considered for Federal Specification approval, based on the comparatively better performance shown by the PVC material in contrast to a history of poor performance by other joint seal materials now covered by Federal Specifications. In support of his recommendation, Mr. Engels also included supplemental information concerning present levels of foreign object damage (FOD) to jet aircraft deriving from deteriorated joint seals, and he developed cost comparisons between the use of presently specified sealants with one year warranties and the PVC materials with up to a ten year warranty.

2. NCEL has reviewed the subject report and has the following comments:

a. Although some of the data provided by Mr. Engels as supplemental information are based on either subjective observations or, as in the case of yearly FOD damage estimates, on suspect information from non-Navy sources, it is noted from NCEL experience that joint sealant materials as presently specified and as presently emplaced often harden, lose bond, or otherwise deteriorate with unacceptable rapidity. Almost without exception, NCEL pavement evaluation and condition surveys found defective joint seals and joint spalls to be the only preponderant defects in portland cement concrete airfield pavements within the Navy and Marine Corps. NCEL can thus support the conclusion that present sealant specifications and application techniques do not produce wholly acceptable joint seal applications.

Enclosure (3)

b. Mr. Engels presented considerable data, both from personal observations and from solicited testimonials, to show that the PVC sealant has been successfully used over a range of facilities and climatic conditions, with most installations in excellent condition after periods of use of up to 10 years. An NCEL engineer has personally viewed the PVC sealant at Los Angeles International Airport which is in excellent condition after almost 10 years in place. Therefore, it appears that the PVC materials may perform at least as well as, and probably better than, some presently specified sealant materials. Also, PVC joint seal life expectancy can possibly be 3 to 4 times that of some presently-used sealants.

c. Poor workmanship in preparing pavement joints and in placing sealant materials may contribute as much as poor sealant properties to early failure of joint seals. An expected advantage of a warranted sealant application, as offered by the PVC sealant manufacturer, may be an increased attention to workmanship in these areas on the part of the sealing contractor.

3. To determine how the PVC sealant relates to present Federal Specifications for joint sealants, NCEL made a brief review of these documents. It was noted that the PVC most nearly corresponded to the SS-S-200D Specification in terms of material properties. As a single component, hot poured material, however, the PVC does not conform to the 200D Specification description of a "two-component, cold-applied" material. The PVC sealant exceeds the requirements of the SS-S-167b and SS-S-1614 Specifications in that it provides for jet blast resistance, as these specifications do not. PVC sealant also costs almost twice as much as the average material provided under the 167b or 1614 Specifications.

4. Although this letter is intended to comment mainly on the subject WESTDIVNAVFAC report, the need for improved joint sealants must be viewed within the context of the exhibited poor performance of joint sealant materials now in use, particularly those supplied under the SS-S-164, 167b or 1614 Specifications. These materials often do not perform in place as required or desired. Common deficiencies include bubbling and/or mushrooming of new seals, loss of bond, and either early loss of resiliency or occasional reversion to a tacky consistency which traps and holds incompressibles. Some of these defects do not show up within the first year of use. In order to improve overall field performance of joint sealants, as well as to allow the use of the PVC sealants on Navy pavements when appropriate and desirable, NCEL suggests the following for consideration by NAVFAC:

a. Tighten the requirements of the present SS-S-164, SS-S-167b and SS-S-1614 Specifications to prevent the use of the poorer, short-lived sealants which occasionally show up under these specifications. This will likely require a review of present specification requirements and conformance tests, and possibly should include consideration of the use of the weatherometer test, as now required for SS-S-200D sealants. Apparently, many materials now acceptable under the 164, 167b or 1614 Specifications cannot pass the weatherometer test. It seems logical to require these materials to be as resistant to weathering as the 200D materials.

b. Improve contractor adherence to required sealant placement techniques by requiring more than a one-year warranty on joint seal performance, particularly regarding sealant bond to the pavement and quality of the sealant materials. One recent joint resealing contract awarded at NAS Lemoore, California, required a five year joint seal performance warranty from the sealing contractor. This was accompanied by a five year material warranty from the PVC sealant manufacturer, who insisted on rigid contractor adherence to specified placement techniques and who provided a representative to ensure such compliance during the initial joint cleaning and sealant application efforts.

c. Consider revising the SS-S-200D Specification to allow the single component, hot poured PVC sealants to be bid under that specification. Such a revision of that one specification would not be a total solution to the overall problem of poor joint seal performance, however, as it appears that materials accepted under other than the 200D Specification are those which exhibit the most deficiencies in field performance.

5. Obviously, the items suggested above would require detailed and critical evaluation before they could be adopted. If NCEL can be of assistance in these areas, personnel and facilities can be made available. Coordination of such efforts can be made with Mr. C. R. White or Mr. D. J. Lambiotte, Soils and Pavements Division, Naval Civil Engineering Laboratory, at Autovon 360-5779 or 360-4085, respectively.

WARREN A. SHAW
BY DIRECTION

Copy to:
NAVFAC (Code 03)
NAVFAC (Code 04)
NAVFAC (Code 043)
NAVFAC (Code 04B1)
WESTDIVNAVFAC (Code 04B, Mr. Richard Engels)

APPENDIX B

STATISTICAL ANALYSIS OF SPECIFICATIONS

The information presented below is a statistical analysis of 107 random samples taken from NAVFAC Publication P-34. The analysis was completed by taking the publication date of each specification.

PROPERTIES OF THE 107 OBSERVATIONS

MEAN YEAR	1966
STANDARD DEVIATION	3
MEDIAN YEAR	1966
MINIMUM YEAR	1959
MAXIMUM YEAR	1974
RANGE	15

BIBLIOGRAPHY

1. Allen, Thomas J., The Differential Performance of Information Channels In the Transfer of Technology, Paper prepared for National Aeronautics and Space Administration, June 1966.

2. Anuskiewicz, Todd, Federal Technology Transfer, National Science Foundation, Office of Intergovernmental Science and Research Utilization, August 1973.

3. Armed Services Procurement Regulation, 1974 Edition, Government Printing Office, Washington, D.C.

4. Doctors, Samuel I., The Role of Federal Agencies in Technology Transfer, Cambridge: M.I.T. Press, 1969.

5. Douds, Charles F., The Effects of Work-Related Values on Communication Between R&D Groups, Part I, Northwestern University, Illinois, August 1970.

6. Essoglou, Milon, Rohrer, J.T., Hankerson, K., Jr., Technology Transfer in the Naval Shore Establishment, Unpublished Paper.

7. Hawthorne, Edward P., The Transfer of Technology, Organization for Economic Co-operation and Development, Paris, 1971.

8. Hendrickson, Jack E., Fisher, William G., Jr., An Evaluation of the Effectiveness of a Research Organization's Mechanism for Transferring Technical Information to Applied And Use, Master of Science in Management Thesis, Naval Postgraduate School, Monterey, California, December 1974.

9. Jolly, J.A. and Creighton, W.J., Technology Transfer and Utilization Methodology; Further Analysis of the Linker Concept, Paper prepared for Naval Facilities Engineering Command, June 1974.

10. Jolly, James A., The Technology Transfer Process: Concepts, Framework and Methodology, Unpublished Paper, Naval Postgraduate School, California, November 1974.

11. Kottenstette, James P., et al., Project for the Analysis of Technology Transfer; Annual Report 1970, Denver Research Institute, July 1971.

12. Naval Facilities Engineering Command TS15P28, General Notes, 1 May 1969.

13. Naval Facilities Engineering Command TS03300, General Notes, December 1974.

14. Naval Facilities Engineering Command P-34, Specifications Use in Contracts for Public Works, June 1974.

15. Olken, Hyman, Technology Transfer: How to Make it Work, Olken Publications, Livermore, California, 1972.

16. Price, Charlton R., The Environment and the Action in Technology Transfer 1970-1980, Denver Research Institute, September 1969.

17. Secretary of the Navy Instruction No. 4858.2B, Department of the Navy VE (Value Engineering) Program, p. 1, 16 December 1972.

18. Steiner, George A. and Vance, Jack O., "Introduction: Selected Papers From a Seminar on Management of Technology Transfer," IEEE Transactions on Engineering Management, Vol EM-16, #3, p. 99-102, August 1969.

19. Stewart, John M., "Techniques for Technology Transfer Within the Business Firm," IEEE Transactions on Engineering Management, Vol EM-16, #3, p. 103-110, August 1969.

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